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Title: System and method for detecting water vapor within natural gas

ENGLISH TRANSLATION OF FOREIGN REFERENCE

Commissioner for Patents
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Sir/Madam:

Applicant hereby encloses an English translation (albeit computer-generated) of DE 3413814 A1.

Respectfully submitted,

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DE 3413914 A1

Procedure and arrangement for the determination of the absolute Feuchtig keit of gases the invention refers to a procedure for the determination of the absolute humidity of gases, whereby a laser beam bundle is emitted within a given frequency spectrum and split up into a that gas penetrating measuring luminous beam which can be examined and into a reference luminous beam, which is measured intensities of the partial luminous beams and determined dependent on a comparison of the intensity measured values the absorption of the gas in a Freuqenzbereich, characteristic which can be examined, of water. Furthermore the invention refers to an arrangement for the execution of this procedure. The determination of the absolute humidity of a gas and/or. Gas mixture takes place in practice after different measurement principles. To it belong the conductivity measurement, the quartz oscillation analysis and the measurement of the change of capacity of a condenser. None of these well-known measuring procedures and/or. the associated measuring instruments is suitable for the control of chemical or physical processes, since they cause an intermittent measured value admission in noticeable Zeitabataenden and or substantial time delays between measured value admission and measured variable processing into the absolute humidity of a gas representing signals. From the DE-A 2,228,493 a procedure of the kind initially specified for determining the water content is well-known in flue gases. Laser radiation is produced by a water vapour laser. The intensitaetsmessung takes place thereby either according to the radiography principle or using a structurally complex spherical measuring chamber after the reflection principle. In the case specified last only the reflected measuring radiation for the determination of the water content of the flue gas sample can be considered. This well-known procedure made possible a rapid and essentially continuous measured value production and is therefore suitable for a sogenante on-line control of chemical or physical processes; the results of measurement of this well-known procedure are however on many, unconsidered measured variables dependently and in each case relatively inaccurate, so that the application type of the well-known procedure are limited. The invention is the basis the task, a practically delay-free working measuring procedure with associated arrangement for the determination of the absolute humidity in gases to indicate in particular in earth gases which ensure a high measuring accuracy at relatively small structural and operational expenditure with large elimination of physical or chemical measured variables. With the solution of this task the invention proceeds from the realization that with the application of absorption-spectroscopic measuring procedures to above all flowing gases both the transmitted portion and the reflected portion of the light energy for the measurement absor of the bierten energy, irradiated into the gas, are to be considered and thus for the determination of the absolute humidity in the examined gas. As well known for example in one a Kaverne inferred natural gas stream macroscopic pollutant particles, like salt grains, are carried glycol, rust etc., which can reflect a relatively high portion of the light energy irradiated into the gas flow. This reflected light energy portion was evaluated with exclusive consideration of the transmission energy with the measurement as absorption energy, so that the result of measurement would be falsified. The solution of the task of invention consists of the fact that additionally for the intensity of the transmitted radiation the intensity of the radiation reflected from the gas which can be examined is instrumentation seized and considered with the determination of the absorption and that the measuring luminous beam is cyclically induced to the scanning of a surface sector transverse to the measuring jet transmission direction and moved Transmissionsund reflection luminous beam after their withdrawal from the gas which can be examined is caught and to the determination by water molecules absorbed of the radiation energy and as a function of it the absolute humidity evaluated. The invention switches thus the measured variables due to pollutants in the gas which can be examined by consideration both by the gas transmitted and the portions of the altogether irradiated light energy reflected from the gas out and increases thereby both the accuracy and the reliability of the won measured values. Also the movement of the measuring luminous beam contributes to the reduction of the measured value influences caused by pollutants. This applies particularly with flowing Gasen1 with those the measuring luminous beam with the flow rate of the examined gas in direction of flow is preferably moved and for a certain volume element of the gas follows. Statistic fluctuations can be compensated by it, be had particularly the pollutants mentioned, like salt grains, glycol particle, rust etc. a flow rate deviating from the gas flow. Preferably the

measuring luminous beam is shifted during a messzyklus from an end parallel to the opposite end of the scanning area and reset afterwards suddenly on the one hand the end. During this parallel movement of the measuring luminous beam a always same radiography distance can be ensured by the fact on use of the usual rotationally symmetric measuring chambers that one puts the scanned surface sector into those or parallel to the rotation axle. Around the water-specific spectral lines more exactly it seizes and thus the measuring accuracy to increase to be able is intended in further training of the invention that frequency-selects the transmitted measuring luminous beam and the reference luminous beam within the frequency spectrum of the laser-emitted radiation and the absorption measured values for several, for which water content typical spectral lines in a computer are evaluated. For the production of a control size for the absolute humidity of the examined gas the phase shift of the transmitted radiation energy of the measuring luminous beam is preferably measured opposite that of the reference luminous beam constantly and determined from this in a computer the actual density of the examined gas and compared with a given density of the examined gas, for example the density of the gas at a well-known value of the absolute humidity. This phase shift can be measured for example by the fact that the transmitted Messstrahlenbuen del again split up and with a reference luminous beam to the Interferrenz brought wird.In alternative procedure knows one the phase positions of the transmitted measuring radiation and the reference radiation in addition, to measure individually and in a computer for the determination of the density of the examined gas compare with one another. By depresses the measuring radiation through the examined gas caused phase shift can in well-known way through production by rotary field signals be determined electronically. While with practically all conventional measuring procedures the absolute humidity of a gas could be measured only with relaxed condition of the gas with sufficient accuracy, the invention is suitable also for the determination of the absolute humidity in gases which are at pressure. Here the pressure and preferably also the temperature of the gas is measured. The pressure and temperature levels are considered for the compensation of the druckverbreiterung of the water-specific spectral lines with the determination of the absolute humidity in a computer. The druckverbreiterung is an effect, which is to be observed with the spectrographic analysis from gases which are at pressure to. Under pressure the intensity is decreased with appropriate widening of the spectral lines. With the preferential use of the invention for the determination of the absolute humidity of natural gas a pulsed laser with an emission spectral region is preferably used from 2,63 to 2.7 over, whereby one avoids to the characteristic spectral lines of the not negligible portions of methane and CO2 to a large extent. The arrangement according to invention for the determination of the absolute humidity of gases is characterized by the fact that in the path of rays of the measuring luminous beam between the Messstrah lenbuendel and the reference luminous beam splitting off beam splitter is arranged and the measuring chamber a scanner mechanism, which diverts the measuring luminous beam in such a manner transverse to messstrahlengang that it scans a given surface sector of the measuring chamber periodically and that the path of rays of the radiation reflected from the measuring chamber is directed over the scanner mechanism led back and toward a further, the intensity of the reflected radiation seizing detector, which is connected with the computer. This scanner mechanism is trained preferably in such a way with the fact that it shifts the measuring luminous beam within the surface sector parallel. In the following the invention is more near described on the basis a remark example of an arrangement represented schematically in the only figure for the measurement of the absolute humidity by flowing natural gas which is at pressure. A color center laser 1 produces a light-beam bundle, within a wavelength coverage from 2,63 to 2,7um, in which the characteristic spectral lines of water lie, so that this light energy is particularly strongly absorbed by water. The light emitted by the laser 1 is split up by a beam splitter 16 into a measuring luminous beam 20 and a reference luminous beam 21. The measuring luminous beam steps into a scanner 2, into which it it is diverted periodically in such a manner that from the scanner of 2 withdrawing luminous beams within a given scanning area one shifts. For this purpose the scanner 2 points a multi-surface turning mirror 26 and a being certain lying in the path of rays of the occurring measuring luminous beam, to the drehspiegel opened hollow and/or parabolic reflector 25 up those mirrors 25 and 26 lies bent to the measuring luminous beam 20 easily, so that the radiation, in the direction of which gas which can be examined, reflected by the mirror 25, over which multi-surface turning mirror 26 runs away. The idea place of the measuring luminous beam on the

multi-surface turning mirror 26 lies in the focus of the parabolic reflector 25, so that on latter thrown measuring luminous beam 20 in all turning positions of the multi-surface turning mirror 26 parallel by the parabolic reflector 25 one reflects. The measuring luminous beam becomes therefore due to the circulation of the drehspiegels 26 within one by the pulled through line 20 and the dash-dotted line 20' limited scanning area to a pipe 15 thrown, which is flowed through by the natural gas which can be examined. The pipe 15 is in the range with suitable windows, re-painted over by the moved measuring luminous beam, 15' provided, which consist the measuring radiation of not absorbing material. The movement of the measuring luminous beam in the scanning field is steered in such a manner in accordance with condition of the control signal developed by a controller 4 as a function of a volumetric flow meter 5 that the scanning speed, with that the measuring luminous beam 20 in the scanning area 20, 20' , equal the flow rate of the examined gas be up this way is moved a certain volume element of the gas, which flows by the tubular measuring section 15 permeable for the messstrahl, for a certain time by the measuring luminous beam under perpendicular Inzidenz is accompanied. The portion of the energy of the measuring luminous beam 20 reflected by for example macroscopic foreign bodies becomes over the scanner 2 on the back of the beam splitter 16gewor fen. This back is total by suitable remuneration reflecting, so that that reflection path of rays is returned on a photodetector 9. The intensity of the reflected radiation is seized in this detector 9 and considered over a computer during the final evaluation. The transmitted portion of the measuring luminous beam becomes over as a whole with 3 designated transmission device and in as frequency lesson device working circular letter-variable filter 24' the intensity of the transmitted radiation seizing detector 10 supply those transmission device 3 exhibits with the described remark example two stationary hollow and/or parabolic reflector with the mirrors 25, 26 appropriate inclination to the measuring luminous beam 20, of those the transmitted radiation fan catching parabolic reflectors 27 larger width and focal length has than the second parabolic reflector 28. The two parabolic reflectors are in such a way arranged that their focuses in one point collapse. From the smaller parabolic reflector 28 reflected and on the detector the 10 arranged jets of the cyclically moved jet fan run therefore parallel. They are bundled optical elements through not shown and on a beam splitter 18 steer through between the transmission device the 3 and the frequency lesson device 24' in the path of rays of the measuring radiation arranged beam splitter 18 a certain portion of the transmitted light energy is directed toward a partially transmitting mirror 19. A reference luminous beam 22, which is divided by a beam splitter 17 from the reference luminous beam 21, is supplied to a detector 11 by way of the partially transmitting mirror 19 just like the portion of the transmitted light energy abgespaltene at the beam splitter 18. By interference with the reference luminous beam 22 the phase shift of the light energy transmitted by the measuring section 15 is intended and determined in the computer 7 the actual density of the examined gas, in order to win a control value for the absolute humidity. As a result of comparison of the light energy, which is reduced by absorption of the water molecules in the measuring section, with the light energy of a reference jet 23, derived seized by the detector 10, seized in a detector 12 from the reference jet 21 a measure for the concentration of the water molecules arises and thus for the absolute humidity of the examined gas with consideration of the reflected light energy won in the detector 9. Likewise in as frequency lesson device working circular letter-variable filter 24 is assigned to the detector 12, that with the filter 24' if necessary synchronously turns. An asynchronous turn of the filters 24 and 24' can be considered by the computer. With the increased pressure of the examined gas measured values are necessary for pressure - measuring instrument 13 - and temperature - measuring instrument 14 -, which are conveyed to the computer 7 directly over analog/digital transducers. After dressing of the measuring signals by the computer 7 the absolute humidity as well as the appropriate dew point in a plotting device are digitally indicated and/or registered to 6. The determined values can be used directly for the process control for example with the drying process of Kavernen taken natural gas. Under that managing used Begriff"Gas" fall also gas mixtures, including such, in those foreign matter, as macroscopic solid particles or liquid molecules are carried.